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ABSTRACT

The meaning of success as experienced by students in statistical methods courses was studied. Six social science graduate students who had completed several statistical methods courses were interviewed. The qualitative method of phenomenology was used to understand the essence of success by analyzing the students' experiences and perceptions. The students described success as an accumulation of conceptual knowledge that they are able to apply and communicate to others. They experienced success predominantly in the context of working in study groups. Success was precipitated by, and coupled with, positive feelings such as confidence and happiness. Appendixes contain the study cover letter and a transcribed interview. (Contains 44 references.) (Author/SLD)

The Meaning of Success for Students in Statistical Methods Courses: A Phenomenological Study.

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Paper presented at the 2000 annual meeting of the American Educational Research Association in New Orleans, LA.

Abstract

The meaning of success as experienced by students in statistical methods courses is described. Six social science graduate students who had completed several statistical methods courses were interviewed. The qualitative method of phenomenology was used to understand the essence of success by analyzing the students experiences and perceptions. The students described success as an accumulation of conceptual knowledge that they are able to apply and communicate to others. They experienced success predominately in the context of working in study groups. Success was precipitated by and coupled with positive feelings such as confidence and happiness.

My Experience with Success

As a graduate student in a quantitative and qualitative methods program, I have been involved in various ways with many statistical methods courses. This involvement has ranged from participating in courses as a student, to helping professors instruct and prepare for class as a teaching assistant, to conducting my own course as an instructor for undergraduate students. In each of these positions I have thought about the issue of competence and success.

As a student who is persistent in learning, I feel that competency is a necessity to feeling successful. The minimum requirement to feeling satisfied with my performance in a statistical methods course is competence with the skills and concepts presented in that course. I, however, strive to find a deeper understanding of the material and to uncover the relationships between the new information learned from the class and my pre-existing knowledge. It is when I can make these connections between newly learned concepts and my established mental structure of highly familiar concepts that I can feel some sort of accomplishment.

As I am approaching completion of my coursework in my program of study, I have been trying to yet again assess my understanding of the statistical methods I have formally studied. During the past year, I have been struggling with my definition of success when dealing with the material presented in these courses. My meaning of success seems to change with each course I complete.

In trying to assess my success as a graduate student participating in statistical methods courses, I would often consider how I measured success as a teaching assistant and as an instructor for these types of courses. In doing this, I realized how differently success was defined for each of the graduate-level courses I assisted with and how those courses differed from the definition I used in teaching my own undergraduate course. The one consistent finding was the difference between the outcomes that were considered indicative of success for the courses I taught or assisted compared to the outcomes constituting my definition of success as a graduate student participating in a course.

To add to my confusion, I have received top grades as a student in all my statistical methods classes even though I have not felt successful in all of them. The question that remains is, why if I meet the criterion of success set by professors, do I still feel unsuccessful in these courses. I now wonder if some of my students who receive top grades feel unsuccessful in my course. Would this inconsistency be due to lowered standards, poorly written tests or failure to address the skills or concepts the students wish to learn in my class? These issues come to mind for they are among the reasons I explain the inconsistency between the formal assessment of my performance and my personal feeling of success in statistical methods courses. This same type of inconsistency is evident when success is felt by the student even though course grades are low.

All of these questions and the confusion led me to ask, "what is success for those students who do feel successful in graduate level statistical methods courses?". Also,

and of equal importance, "how is this success experienced and in what context is it experienced?".

Review of the Relevant Literature

There is a body of research that focuses on the understanding of statistical methods. Specifically, studies exist that investigate student success within this discipline. In synthesizing these studies, one soon finds that success in this discipline is defined in numerous ways.

Aiken, West, Sechrest & Reno (1990) surveyed 186 programs in psychology to examine the number and breath of statistics, measurement and research design courses offered. The general finding relating to statistical training was that graduate students were judged competent in applying "old" or traditional techniques of data analysis to their own research, but they were not competent in applying new and often more useful techniques, including multivariate techniques, causal modeling and data treatment techniques.

Lehman, Lempert & Nisbett (1988) also examined graduate training in statistics. They investigated the relationship between statistical training and success in answering statistical reasoning problems. Specifically, they examined the effects of graduate study in psychology, law, medicine, and chemistry on statistical and methodological reasoning and reasoning about problems in the logic of condition. They found that psychology majors made the largest increase in these skills. This increase was attributed to the extensive statistics and methods training that psychology students completed compared to the training of students studying the other disciplines. The implication was that the training that psychology students received facilitated successful completion of problems addressing everyday-life events that demand statistical reasoning skills.

A third report, which assessed student understanding and success in statistics in yet another way, noted that students are often unable to apply techniques learned in classrooms to real-world problems (Federer, 1978). The explanation of this inadequacy was that statistical methods courses spend too much time discussing hypothesis testing and significance issues and therefore neglect the importance of statistical design. The study emphasized how students are not equipped to apply procedures to real-world problems because they have only been exposed to "classroom data" in which the assumptions have been met. These experiences hinder successful application of statistical procedures to everyday problems that many students will encounter on the job or with their own research. To overcome this problem it was suggested that more time be spent discussing statistical assumptions, methodology and sampling issues prior to discussing statistical inference and that students participate in group survey projects.

In yet another study, importance was placed on successful use and understanding of technology in computational statistics (Eddy, Jones, Kass & Schervish, 1987). Specifically, it was stated that all graduate students, even those not specializing in statistics, should understand the theory and methods of computing. Students

successfully completing these courses would understand numerical techniques such as linear algebra and maximum likelihood and should be skilled in simulation methods.

Moore, Cobb, Garfield and Meeker (1995) also discussed the importance of technology to the understanding and use of statistical procedures; however, the emphasis was not on computing statistics. The report stated that, in general, Americans are dissatisfied with the mastery of quantitative concepts and skills. One reason for this dissatisfaction may be that the skills that are taught are not employable in today's world. Discussion focused on the role of technology in the classroom in the preparation of statistically competent students and the goal of producing students with conceptual understanding of statistics rather than mere memorization of algorithms.

In addition to the above articles, there are several that include more specific definitions of the skills that students should acquire while participating in statistics courses (Gal & Garfield, 1997; Garfield, 1995). For example, Gal & Garfield (1997) present a detailed outline of their goals of statistics instruction. Successful students would be able to do the following:

> (1) Comprehend and deal with uncertainty, variability, and statistical information in the world around them, and participate effectively in an information-laden society.
>
> (2) Contribute to or take part in the production, interpretation, and communication of data pertaining to problems they encounter in their professional life (p. 2).

These goals are further broken down into the following subgoals: understand the purpose of statistical investigations, understand the process of conducting a statistical investigation, obtain the procedural skills used in statistical investigation, understand relationships among statistical concepts and procedures, understand probability, develop statistical literacy skills, develop the ability to effectively communicate statistical information, and develop an appreciation for statistical methods as a useful tool for understanding the world around them. The chapters that follow this description focus on how to assess success at reaching these goals.

Similar to Gal and Garfield's (1997) goals, Sowey (1998) stated that students completing statistical methods courses should be able to retain their knowledge beyond the classroom and have the ability to use it in the workplace. In order for this to take place, students should understand the relevance or purpose of the course and discipline to their lives and have an understanding of the relationship or structure of statistical concepts.

Kelly, Sloane, and Whittaker (1997) focus more specifically on importance of developing conceptual knowledge. They believe students should be able to choose the appropriate tool to solve a problem, have the ability to explain why the tool is appropriate, possess the skills to apply the tool, and possess a deep enough understanding of the concept to know the limitations of the conclusions drawn from the solution. They provide examples of students who "successfully passed" a course focused on analysis of variance, yet the students were unable to talk about the new concepts learned in the course. Examples of assessment that help identify the level of

conceptual knowledge are given so that students do not continue to pass courses with a simple surface understanding of the content.

The importance of developing and assessing conceptual understanding in addition to computational skills was also voice by Huberty, Dresden and Bak (1993). They defined conceptual knowledge as the cognitive connections among facts, among procedures, and between facts and procedures. They found that conceptual knowledge is distinct from propositional and procedural knowledge for students participating in an introductory statistical methods course. In particular, they found that students did not have good conceptual understanding of statistical methods and they therefore suggest that this type of knowledge be expected and assessed to the same extent as propositional and procedural knowledge in these courses.

Since there are several different definitions of the skills successful students should acquire, numerous studies are reported each year implementing different activities, strategy instruction and teaching styles to increase student success. Many of these studies simply describe a technique that can be used by the instructor in the classroom. These studies focus on reducing anxiety (Dillon, 1982; Jacobs, 1980), making statistics relevant (Beins, 1985; Dillbeck, 1983; Shatz, 1985), teaching specific statistical concepts (Johnson, 1986; Levin, 1982; Rossi, 1987) and general techniques that are used daily in class (Potter, 1995). The problem is that these studies rarely provide the reaction of the students to these new activities or techniques. If students feel more successful in these courses after participating in these activities it is rarely evaluated or reported. If student reactions are provided, they are usually quite brief, consisting of only a few lines or a paragraph at most.

There are also studies that have been conducted that actually manipulate a technique or activity and evaluate changes in student success by examining differences in test scores or assignments (Beins, 1993; Magnello & Spies, 1984; Ward, 1984; Ware & Chastain, 1991). Again, none of these studies offer the students' opinion of these specific activities or ideas concerning students' feelings of success when they completed the course.

In addition, there are studies which present a dramatic change in teaching methods. For example, Smith (1998) described the transition from a completely lecture-based course which used traditional forms of assessment to a course that emphasizes authentic assessment almost equally. The students completed several group projects which allowed them to collect and then analyze data, develop writing skills, and practice reporting results in a public forum. When comparing course grades to those from previous years using the lecture format, students exposed to this new teaching style performed better. In addition, students were asked to voice their opinions about the teaching methods, and they strongly endorsed it. Specifically, students indicated that the course format facilitated understanding of the material, and development of skills to intelligently write and speak about data analysis. While these results provide insight into what activities students enjoy and view as helpful to learning, it is not clear if mastering these skills constitutes being successful in this course from a student perspective.

Garfield (1995) also describes how courses can be modified by realizing that students learn by (1) constructing knowledge, not simply absorbing information; (2) participating in cooperative learning groups; (3) practicing applying new concepts to novel situations; (4) predicting outcomes of problems prior to solving them; (5) using computers to visualize data; (6) receiving feedback on their performance. In addition, she explains that instructors often overestimate student knowledge, students typically place value on what is being assessed, and that instructors should try different teach methods and assessments.

The Problem

While there are numerous studies reporting what experts perceive success to be in the area of statistical methods and in what context this success is most likely experienced, there are none giving voice to the students' perspective of success. I believe that lifting the voices of the students is another and possibly better way to understand student success in statistical methods courses. We must understand what success is in these courses for the students who complete them. By studying only empirical predictors of success or operational definitions of success constructed by experts, we ignore the essential structure of success as experienced by the student completing the course. By asking the students about their experiences with success and the meaning they ascribe to these experiences, one will understand success from the students' perspective. This information would be valuable for instructors preparing to teach these courses. By identifying what constitutes success from the vantage point of students, instructors can then provide students with instruction that incorporates activities or techniques that promote feeling successful in the classroom.

The purpose of this phenomenology is to describe the meaning of success for students in statistical methods courses. The central research question is as follows: What is the essence of success for students in statistical methods courses? The following are more precise subquestions relating to the central question: What meanings can be ascribed to the experience of success? What are the invariant themes across students that define success? In what context are students experiencing success?

Methodology

Phenomenological Approach to the Problem

The phenomenological method is used as an attempt to understand empirical issues from the perspective of those being studied. The basic premise of phenomenology, as stated by Husserl, is that all knowledge is grounded in human experience (Polkinghorne, 1989). As stated above, the purpose of this study is to understand the essence of success in statistical methods courses as experienced by students. The phenomenological approach was taken so an understanding of the phenomenon of success as constructed by students could be attained. This entails distinguishing the invariant and essential aspects of the phenomenon of success as experienced by those experiencing it (Polkinghorne, 1989). Moustakas (1994) states that "The challenge facing the human science researcher is to describe things in themselves, to permit what

is before one to enter consciousness and be understood in its meanings and essences in the light of intuition and self-reflection" (p.22).

Phenomenological studies aim specifically at answering two basic questions about the phenomenon: what is the phenomenon and how is it experienced. The methodology used to find answers to these questions is based on some broad philosophical ideas. Specifically, phenomenology follows four philosophical tenets or themes in order to uncover the meaning of an experience for a number of individuals. The following four philosophical themes characterize phenomenology: "a return to the traditional task of philosophy, the search for a philosophy without presuppositions, the intentionally of consciousness, and the refusal of the subject-object dichotomy" (Stewart & Mickunas, 1990, p.5).

The first theme states that phenomenology is based on the traditional view of philosophy. Specifically, this view states that people naturally seek wisdom and knowledge. "Man desires knowledge of himself and his world, and it is philosophy's task to achieve such understanding " (Stewart & Mickunas, 1990, p. 5). The quest for understanding was narrowed to gathering empirical data by the end of the 19th century. This shift was referred to as scientism by phenomenologists. An extreme form of scientism, logical positivism, was based on the premise that the only meaningful propositions were empirically verifiable or analytically true. Phenomenologists believe that the positivist approach to philosophical activity is much too narrow. Through phenomenology one can return to the broader task of philosophy, that of understanding the world.

The second theme, a philosophy without presuppositions, states that assumptions pertaining to the nature of reality must be set aside in order to acquire a clear lens in which to view experiences. "The aim of phenomenology is to suspend all such questions while turning to the content of consciousness itself—to the phenomena—and to see philosophy's task as being that of describing the essences of phenomena, the explication of the various levels of meaning of phenomena, and their interrelationships" (Stewart & Mickunas, 1990, p. 8). The suspension or bracketing of assumptions is labeled "epoche". This epoche enables a description of the phenomenon unencumbered by presuppositions. "In Epoche, the everyday understandings, judgements, and knowings are set aside, and phenomena are revisited, freshly, naively, in a wide open sense, from the vantage point of a pure or transcendental ego" (Moustakas, 1990, p. 33).

The third theme, the intentionality of consciousness, states that consciousness is always consciousness about something. "Husserl seized upon the significance implied by the recognition that consciousness is always directed toward an object: there is an indissoluble unity between the conscious mind and that of which it is conscious" (Stewart & Mickunas, 1990, p.9). Moustakas (1994) states "intentionality refers to consciousness, to the internal experience of being conscious of something; thus the act of consciousness and the object of consciousness are intentionality related" (p. 28).

The final theme is the refusal of the subject-object dichotomy. There is no distinction between the content of consciousness and consciousness. There is a shift

from the question of reality of the world to the meaning of what appears in consciousness. "Experience is a reality that results from the openness of human awareness to the world, and it cannot be reduced to either the sphere of the mental or the sphere of the physical" (Polkinghorne, 1989, p.42). Reality of the object is derived from the meaning ascribed to it; the meaning is developed by the person conscious of the object (Stewart & Mickunas, 1990). " In other words, perception of the reality of an object is dependent on a subject " (Moustakas, 1994, p. 27).

Based on these broad philosophical themes, the tradition of phenomenology states that in order to understand the texture and structure of a phenomenon, such as success, the perceptions of that phenomenon from those experiencing it must be gathered. The ontological assumption of this tradition is that reality is subjective and there are multiple perspectives of reality as experienced by different people. For this reason, multiple reports of a phenomenon must be gathered in order to understand the underlying invariant structure of a phenomenon (Moustakas, 1994).

Methodologically, this approach is inductive in nature, moving from individual significant statements about the phenomenon to a final exhaustive description of the essence of the phenomenon. The rigorous methodology requires differentiating between the essential and unessential elements of the phenomenon (Polkinghorne, 1989). As stated above, this approach stresses that prior to the data analysis, the researcher set aside presuppositions pertaining to the phenomenon. In order to describe the phenomenon of success as experienced by others, I, as the researcher, must bracket my own views or preconceptions about the phenomenon. Moustakas (1994) explains how epoche can be a frustrating and difficult practice. This process consists of reviewing personal thoughts and feelings regarding the phenomenon in order to set these biases aside. Writing down preconceptions and reflecting upon them prior to the data analysis helps to clear the mind. My epoche, which began the paper, gives the reader an idea of my intersubjective reality of the phenomenon of success and brackets my preconceptions prior to data analysis.

Data Collection

Participants in the study were chosen based on a purposeful sampling strategy. Criterion sampling, which limits participants to those meeting some criterion, was judged as the best method for selecting participants (Miles & Huberman, 1994). The specific criteria were as follows: the student was enrolled in a graduate program in the social sciences; the student had felt successful in at least one graduate-level statistical methods course; and the student had completed at least three graduate-level statistical methods courses, however, quantitative methods was not the primary area of study. I decided to interview students who have completed several courses because they have more experiences in these courses to reflect upon in comparison to students who have completed only one or two courses. Due to the fact that I am a doctoral student in a fairly small quantitative program and know many of the students within my program personally, they were not asked to participate in the study. Students were chosen from the following programs of study due to the statistics requirement in each: sociology, communication studies, speech pathology and cognitive psychology.

The participants were screened to examine if they met these criteria by simply visiting these departments and asking doctoral students the number of statistics classes they had completed and if they felt successful in any of these courses. If they met these criteria they were asked to participate in a research project that involved an audiotaped interview lasting approximately 30 minutes pertaining to their meaning of success in statistical methods courses.

Six graduate students volunteered to participate in the study. An interview date and time was determined immediately upon agreeing to participate. Three days prior to the interview a letter was sent to the participants via email that reiterated the purpose of the study. This letter served as a reminder of the interview time, a show of appreciation for their participation, but most importantly as a guide to the issues they would be asked to discuss in the interview (See Appendix A).

At the start of the interview, the participants were informed that their responses would be anonymous and that they could stop the interview at any time if they should feel uncomfortable in any way. A few preliminary questions were asked pertaining to the number of statistics classes they had completed and their position within their doctoral program. Three of the students were currently collecting data for their dissertations while the others were planning a dissertation proposal for the following semester. The number of statistical methods courses completed at the time of the interviewed ranged from four to six.

The verbal instructions for the in-depth interview were as follows:

> Think about the statistical methods courses you have completed in which you consider yourself successful. Describe what it means to be successful in these courses.

After completing their description of success they were then give the following instructions:

> Now, focus on one or two experiences in these courses in which you felt successful. Describe your experience as completely as possible.
>
> Specifically, try to describe how you felt and the conditions under which you experienced success.

Participants were only asked to elaborate on comments that were unclear or ambiguous to the researcher. The following prompts described by Moustakas (1994, p.116) were adapted for the interview. These were used when greater depth of the responses was needed. The prompts were as follows:

> What incidents and people intimately connected with the experience of success stand out for you?
>
> What feelings were generated by the experience?

Treatment of Data

The audiotaped interviews were transcribed by the researcher for the purpose of analysis (See Appendix B for sample). The transcriptions were analyzed using a modification of the Van Kaam method of analysis of phenomenological data presented by Moustakas (1994). The following procedures were used for each transcribed interview:

(a) Horizonalization: This step entails listing all the relevant or significant statements pertaining to the experience. Then, repetitive or overlapping significant statements were extracted.
(b) Meaning Statements: From the remaining list of statements, two questions were asked:
    (a) Is there a moment of the experience in this statement that is necessary and sufficient for understanding the experience?
    (b) Can the statement be abstracted and labeled for meaning?
If statements did not meet these requirements they were eliminated.
(c) Themes: The meaning statements were clustered into themes based on similarity.
(d) Validation: A check of the themes against the original transcription was preformed. This was done to verify that the themes were accurate representations of the verbatim transcripts.
(e) Individual Textural Description: This constitutes "what" was experienced for each individual. These were constructed by integrating meaning statements and themes.
(f) Individual Structural Description: This constitutes "how" success was experienced. These were constructed by examining the precipitating factors that account for experiencing success and identifying under what conditions or in what contexts success was experienced.
(g) Composite Textural Description: This constitutes "what" was experienced for the group of students as a whole.
(h) Composite Structural Description: This constitutes "how" success was experienced for the group as a whole.
(i) Essence: This constitutes the combined composite textural and structural descriptions for the group of students. The concatenated descriptions show the essence of the phenomena of success.

Data Analysis and Outcomes:

Significant Statements

I read through each of the transcribed interviews and extracted all relevant statements pertaining to the experience of success. Table 1 contains a representative sample of the significant statements from the six interviews.

Table 1

Significant Statements: The Meaning of Success in Statistics

1.	So, getting the concepts....
2.	...it wasn't as successful mainly because I don't feel like I have as good as grasp on the material.
3.	It's not really a grade thing, the way I feel about it.
4.	And I showed that I did know what I was talking about and I understood the statistics.
5.	I mean there was a class I got an "A+" in that I feel very inept as far as trying to go back.
6.	If I am able to know it and retain it and use it, that's success.

7. Although I got a good grade I don't feel like that was success because I can't use it for anything.
8. You know I was able to understand it and then I was able to apply it to different things.....
9. I think I felt success, this even before, I got the test grade back.
10. Happy [feelings associated with success].
11. Just in general coming up with ideas and talking things over with people.
12. I am thinking I know it, so I can talk about it.
13. ....study partners, that was paramount in my success.
14. I wouldn't say I felt successful without them [study partners].
15. I would say it was their [study partners] encouragement.
16. But I think that [explaining concepts to study partners] helped me, made me feel successful more than just getting a good grade in the class.
17. Because not only was I able to learn it myself but I could teach other people how to do it.
18. I was able to get up there...and show everyone that this is how it works and what the answer is.
19. And I think I felt confident and I felt I think just overly happy with myself....
20. I stopped and said I can do this and I can help other people do it and I felt really good about it.
21. I can convey it in plain and simple English and they [people not in academia] understand.
22. Cause I think we [people in study groups] kinda taught each other.
23. But explaining it to someone else, and then hearing them explain it back to me...
24. I understood conceptually what [instructor] was talking about.
25. And that's huge--understanding why.
26. I did really well on the tests but I don't think that was essential to my feeling like I got it or that I was successful.
27. Then working through what [groups members] knew and the things that I brought into the picture sort of that collaboration kinda hooked up together, so, it was sort of a feeling of interdependence.
28. I felt really successful in working in study groups because we dialogued back and forth.
29. I have a general conceptual framework to operate out of and that's what I need.
30. That was a broad picture, coming back to the big picture, how things are arranged and thinking about statistics and how to use them in the world.
31. That really boosted by efficacy in terms of how to use this stuff and the fact that I have a relatively good understanding of what all is going on here and the concepts underlying.
32. Conceptual understanding isn't useful to me if I can't use it so, there' a dual thing there.
33. It's actually fun which is another marker of success for me.
34. What was really fun was to get in and talk with [group member] about it, a somewhat more knowledgeable peer but he was still learning it at the same time..
35. I want to be able to discuss the concepts with somebody, and if that can't happen then it becomes a frustrating experience.
36. To be successful is that I can take the content and I can use it in my own research in terms of design, my research question, my analysis and my interpretation.
37. I understood exactly what I was doing conceptually and that's what made me feel really successful.
38. It [success] had nothing to do with how I did on a test or homework assignments or anything.
39. Sitting in a group and just talking about it made SO much more sense to me than it would doing some computational homework assignment.
40. What helps me is working with people who are at the same level as I am.
41. To feel successful in statistics courses I needed to feel like I had a FULL understanding of what was going on; not just a partial understanding or these are the steps but I really don't get what's going on.
42. They [group members] were able to help me understand the relationships between concepts and that's what's important.
43. It would be like I wanted to know more then [after experiencing success].
44. There were even fleeting moments when statistics was fun.
45. It's [success] also a matter of being able to communicate it right.

Meaning Statements:

I evaluated each significant statement to examine if it contained an element of the experience that was necessary to the understanding of success. Those statements that did contain necessary elements were retained for further analysis. I then reread the remaining significant statements repeatedly in order to abstract the meaning from each. I was careful to use the students terminology for these meaning statements so I did not severe the connection to the verbatim transcriptions.

Themes

Next, I clustered the meaning statements into themes based on similarity. These themes were then validated by rereading the transcribed interviews and assessing if the theme proposed an idea not present in the original transcripts. Table 2 contains the validated themes.

Table 2
Clustering of Meaning Statements into Themes

Knowledge
1. It was important to the students that they had established a conceptual understanding of the material beyond simple memorization.
2. The students valued an organized knowledge base that facilitated problem solving.
3. The students stressed the importance of being able to convey this knowledge to others including students, peers and professionals.
Application
1. The students emphasized the importance of the ability to apply their knowledge to problems in contexts other than the classroom.
2. Success was often felt after the course was completed when the material needed to be applied and assessed for retention.
Formal Assessment
1. Success was often experienced without knowledge of formal assessment scores.
2. Grades are not viewed as relevant to the feeling of success.
Feelings
1. Students experienced a sense of confidence.
2. Students felt happiness and a sense of accomplishment.
3. Students were pleased with themselves.
Study Groups
1. Success was felt with the context of working in study groups.
2. Study groups forced the students to explain and apply concepts, which contributed to their understanding of the material.
3. Study groups supported the students emotionally.

Textural and Structural Descriptions

After identifying the themes, I constructed the textural and structural descriptions of success for each individual. The six individual descriptions were then combined into a composite textural and composite structural description. The composite textural description is presented in Table 3. This describes what constitutes

success for these six students. The composite structural description is presented in Table 4. This describes how success is experienced and in what context it is experienced.

Table 3
Composite Textural Description of Success in Statistics

Students describe success in statistics as obtaining a conceptual understanding of the material. This understanding goes beyond simple memorization of definitions and allows the students to understand when and why particular techniques are used. The ability to explain, teach and intelligently communicate this knowledge to others with varying levels of familiarity with the material is especially important.

In addition to understanding the characteristics of analyses and relationships between analyses, application of this knowledge is a key factor to feeling successful. Students place great emphasis on the importance of being able to apply this knowledge to novel situations in varying contexts. Since opportunities for these applications may not take place while completing the course, the students often assess success long after the course has been completed.

While students realize that formal assessment of their participation in the course is completed, this assessment is not relevant to their feelings of success. While success is experienced following an exam, it is experienced prior to receiving formal feedback pertaining to their performance. Test scores and grades do not change or impact feeling successful.

Table 4
Composite Structural Description of Success in Statistics

Students experience success in the context of working with peers in study groups. These groups are a strategy used to test their knowledge, application skills and ability to explain concepts, the three components of success. In addition, success is experienced in the study groups due to the social support provided by the group as a whole. Students feel emotionally supported and encouraged by the group members which promotes feeling successful in the course. Students emphasize the importance of seeking out opportunities to participate in study groups so that feelings of success can be experienced.

Feeling successful comes from being in a situation where one feels confident, that is, being situated within a structure that one feels adequately prepared to handle. Confidence in oneself promotes feeling successful. Students also experience a sense of accomplishment and happiness with their ability and performance. The students are pleased with themselves and value the situation in which they find themselves.

The Essential Meaning of Success

I synthesized the composite textural and structural descriptions of success to arrive at the essence of success for students who feel successful in statistical methods courses. Table 5 presents this exhaustive description of the phenomenon of success.

Table 5
The Essential Meaning of Success for Students in Statistical Methods Courses

Success, as experienced by graduate students participating in statistical methods courses, constitutes acquiring knowledge of the material, the ability to apply the knowledge and the ability to communicate this knowledge to others. Being successful is subjective in nature. Formal assessment is not relevant to the meaning or feeling of success. Study groups, however, play a major role in promoting success and is the context in which much success is experienced. Feelings of confidence, accomplishment and happiness precipitate and couple the feeling of success.

Discussion and Implications

The purpose of this phenomenology was to describe the meaning of success for graduate students who had completed several statistical methods courses. The essential components of success for these students were found to be similar to some of the goals stated by researchers and instructors in the area of teaching statistics (e.g. Gal, & Garfield, 1997; Huberty, Dresden, Bak, 1993; Kelly, Sloane, & Whittaker, 1997; Sowey, 1998) Specifically, students noted that success constituted a solid conceptual understanding of statistical methods, a organized framework of this knowledge that facilitated problem solving, an ability to communicate statistical knowledge, and an ability to apply these skills to solve problems that are of interest to the students. Success was felt in two contexts: environmental and emotional. The environment in which students were most likely to feel success was in self-made cooperative learning groups. Members of these groups engaged in activities such as explaining concepts to other group members, and modeling problem-solving skills. These activities can be described as informal performance assessments which forced students to evaluate the skills they identified as being essential components of success. In addition, the cooperative learning groups provided a safe environment for learning and supported the students in their effort to learn. Finally, success was felt in the context of feeling confident and prepared to apply or explain statistical concepts and methods. This confidence was coupled by a feeling of satisfaction, happiness and excitement.

Further discussion of these findings will be completed in terms of the implications for teaching practices in the area of statistical methods. In doing so, suggestions and references for activities and assessment methods are provided that relate to each of the essential components of success and the contexts in which success is most likely to be experienced.

Statistical Instruction Practice:

When examining the meaning of success as experienced by students, several important issues arise pertaining to classroom instruction. First, success was described by students as establishing (1) a conceptual understanding of the material, (2) an organized knowledge base that facilitated problem solving, (3) the ability to convey statistical knowledge to others and (4) the ability to apply knowledge to research problems outside of the classroom. While all of these components are interrelated, specific teaching practices for each are noted below. These can be easily implemented to

facilitate students' achievement of each of these goals and therefore promote feeling successful.

Developing Conceptual Understanding

Comments such as, "So, getting the concepts and being, feeling confident that I really have a good grasp of what we are looking at—the concepts and why we are doing what we are doing", and "You can memorize the formulas but not really know what you are doing" convey that students need to move beyond surface learning in order to experience success. The importance of establishing a conceptual understanding of the material has also been stressed by researchers (e.g., Gal & Garfield, 1997; Moore, Cobb, Garfield & Meeker, 1995). Hubbard (1997), Kelly, Sloane, and Whittaker (1997), and Steinhorst and Keeler (1995) present examples of how instructors can assess conceptual knowledge in order to promote deep learning. If students are required to think about what they have learned instead of just reproducing facts on exams, they are more likely to establish a strong conceptual understanding of the material. Interestingly, when discussing the importance of a conceptual understanding of the material, none of the six students voiced a necessity for knowing skills related to computational statistics (Eddy, Jones, Kass, & Schervish, 1987).

Developing a Statistical Schema

Closely related to the importance of developing conceptual knowledge is the emphasis students placed on an organized knowledge base that facilitated problem solving. The following comments illustrate this: "They [group members] were able to help me with understanding the relationships between concepts and that's what's important" and "I suppose maybe I have a list of options and I am feeling maybe I can choose from these options of what I can do. It seems like if I am presented with a problem then I am able to come up with a number of solutions and so all these things just cohese." Students were voicing the importance of understanding statistical relationships or developing a statistics schema for the use in problem solving. This supports the recent emphasize placed on the development of this skill by statistical methods instructors and researchers (e.g. Gal, & Garfield, 1997; Huberty, Dresden, & Bak, 1993; Shau & Mattern, 1997; Sowey, 1998).

One method instructors can use to help facilitate the production of an organized statistics schema is through the use of advanced organizers. Advanced organizers provide a framework of the to-be-learned material and can take various forms (paragraphs, hierarchies, drawings, etc.). They have been found to be beneficial to learning when (a) students won't make connections between prior knowledge and new material on their own, (b) students actually use the organizer, and (c) students have time to study the organizer and the to-be-learned material (Corkill, 1992). One simple strategy instructors can use is to present a hierarchical advanced organizer (also called concept map) of the statistical concepts to be covered in the course on the first day. Each class period would begin by presenting the organizer and explaining where today's concept fits in relation to the others. This enables students to relate what they are leaning that particular day to the material they have already learned. This can help them to encode the material in an organized fashion which will facilitate retrieval later.

Another option is to use the organizer as a learning activity by having students create their own organization of the concepts as a semester-end project. The purpose of the organizer shifts from an advanced framework used to help structure students' schemas to an assessment tool. This may be a very difficult task for introductory statistics students since they have limited prior knowledge pertaining to statistical methods. A compromise between the two suggestions is to use an advanced organizer everyday but then have the students create a new organization of the concepts as a semester-end project. This will illustrate that there are numerous relationships between the concepts. It may be helpful for students to present their organizations to the class to make the students more aware of the numerous ways this knowledge can be structured. It follows that students will then encode the material in several different ways which will aid in the retrieval of the information later. For advanced students who participate in several statistics courses, a more challenging activity would involve creating an organization of how the newly learned material relates to statistical concepts already learned. Additional ideas related to the organization of statistical concepts are presented by Shau & Mattern (1997). They present some examples of hierarchical organizers for introductory statistics courses along with guidelines as to how to use them as assessment tools.

Developing Communication Skills

While the acquisition and organization of knowledge both constitute important elements of success, being able to communicate this knowledge to various groups of people was also a necessity for feeling successful. The following quotes illustrate the importance students place on the ability to communicate the information; "I mean grades are nice and we have to get grades but I think I've been...I am more happy and feel more successful if I can take what I learned and apply it and use it in the classroom because teaching is what is important to me. But if I know I can take it somewhere else and teach someone how to do it and help them how to use the tools and the skills that I've learned then I feel like...successful. And that's more important to me than getting a good grade in the class", and "It's [success] also a matter of being able to communicate it right". The importance of students verbalizing their knowledge has been addressed in past research (Garfield, 1995; Smith, 1998). Instructors can promote the development of this skill via cooperative learning groups and performance assessment. Since these two activities were identified as the contexts in which success was most often experienced, suggestions for activities to develop communication skills will be included in the discussion of group work and performance assessment.

Developing Application Skills

Finally, the ability to apply knowledge was a critical component of success. The students explained that feeling successful in applying knowledge often comes after the course is over and in different contexts than a classroom. For example, "You know I was able to understand it and then I was able to apply it to different things and go out of the classroom and actually think oh wow, I could do this or I could do that with the statistics I learned in there", "It's interesting cause I think I'm finding that I feel more successful in some classes even after I've taken them then I did at the time", and "So

that's what I thought was successful about it was being able to take it out of the classroom and apply it." The importance the students place on their ability to apply learned skills to real world research projects supports suggestions from others to emphasize this skill in the statistics classroom (e.g., Aiken, West, Sechrest, & Reno, 1990; Federer, 1978; Gal, & Garfield, 1997; Hubbard, 1997). Similar to communication skills, the ability to apply skills to real world data can be included in a course through authentic assessment. Therefore, suggestions pertaining to implementation of these activities will be discussed in the context of authentic assessment.

The importance of formal assessment

Before discussing the context in which success was experienced, it is important to note that while knowledge acquisition and organization, along with the ability to apply and communicate the concepts were essential elements of success, formal assessment was viewed as irrelevant to feeling successful. All students had strong feelings about grades and test scores, and they were very clear in explaining that neither affected their feelings of success; "I think I felt successful, this even before I got the test grade back", "My success is not the grade", "I would rather get a 'B' in the class and know it really well", "I think an 'A+' doesn't mean a hill of beans if you get out of there and don't know crap", and "It wasn't the 'A' that felt successful, it was gee, God, I know." It would be interesting to investigate whether the same comments are voiced by undergraduates or if formal assessment is an essential part of feeling successful for them.

Students experienced success in two contexts: environmental and emotional. The environmental context in which success was experienced most often was cooperative learning groups. Within these groups, students engaged in activities resembling informal performance assessments. Both cooperative learning groups and performance assessment can be easily implemented into a classroom setting. Emotionally, success was experienced when the student felt confident and prepared to handle the task at hand. This leads to a sense of accomplishment and a valuing of the skills they have acquired. The emotional context in which success is experienced relates to research in the area of self-efficacy. As will be described below, cooperative learning groups influence self-efficacy, which can help explain the importance of cooperative learning groups to the experience of success.

Cooperative learning groups

Students experienced success in the context of studying with peers. The importance of these cooperative learning groups was consistently stressed by all the students. For example, when asked "What incidents and people intimately connected with the experience of success stand out for you?" every student immediately indicated their study partners. The students explained that they sought out these gatherings because the activities practiced in the study groups tested the students' level of success with the material. Specifically, the students engaged in explaining and applying their acquired knowledge. For example, "I was able to explain what had happened in class to the people in the study group, which helped me learn even better."

There is a body of research that speaks of the benefits of cooperative learning groups (e.g. Garfield, 1993; Johnson, Maruyama, Johnson, Nelson & Skon, 1981; Rau & Heyl, 1990). The research shows that students become more intrinsically motivated, have higher expectations for success, persist at the task longer, and can improve achievement. This would indicate that incorporating cooperative learning groups within the graduate-level statistics classroom would be beneficial to students' learning and may also appreciated by the students.

In terms of student learning, Garfield (1993) explains that cooperative learning groups in statistics courses promote student-constructed knowledge instead of simple rote memorization of statistics facts. This helps student to develop a better conceptual understanding of the material, which is an essential component of feeling successful. Moreover, Garfield (1993, 1995) explains that group work allows students to verbally communicate their understanding of the statistical concepts, which makes them more aware of and involved in their own learning. Group work also provides them with practice; and simply put, students learn what they practice. If they practice critical thinking, communicating ideas, and explaining concepts they will become more proficient at these skills. Since these are the skills they view as essential to success, these are often the activities undertaken in the students' informal cooperative learning groups. By creating cooperative learning groups to be used during class, students also have the added benefit of receiving immediate feedback from not only group members but from the instructor. Additionally, the instructor has an immediate gauge on student learning.

Cooperative learning groups also provide students with a safe environment to exchange ideas and develop problem-solving skills. Students indicated that they were involved in these activities when they experienced the feeling of success; "And I think again it's confidence because when we study in groups we feel like if we can explain it to someone else so they understand it then we have it and we understand it and we are successful with it", and "So, you feel successful if you're with a group of people in a study group and you can sit there and go through something that you view as very complex and complicated and still you understand it and you know it and you know why you are doing it and you can use it in a practical way." Not only were cooperative learning groups a safe environment to test acquired skills, they provided social support to the individuals which students indicated was a condition to feeling successful as noted by the following quotes; "That was paramount. Not only working together with them but the emotional support that they provided", "I would say it was them with their encouragement", and "It was their support that kept building my success." Gal & Ginsburg (1994) indicate that problem-solving skills are developed in an environment in which students feel safe to struggle with concepts and problems, present their ideas and try different strategies. Cooperative learning groups seemed to provide this type of environment for these students with the added benefit of supporting the students' efforts.

A simple cooperative learning activity such as presenting a problem and having teams of students present their approaches to solving the problem along with a critique

of the other groups' approaches would be a learning method valuable to both the instructor and students. Students would be verbally communicating their thoughts, evaluating other methods presented for solving the problem, and arguing for their proposed method. This activity forces them to practice all of the skills they view as essential to success. Incorporating this type of activity into a class setting would not be difficult and would model the activity for those students who have yet to discover it. Additional suggestions for cooperative learning group activities in statistics courses are presented in Garfield (1993). For those interested in assessing problem-solving behavior within a group context, Curcio and Artzt (1997) present an assessment tool and illustrate its use with a graphing exercise.

The emotional context of success

Students experienced success when situated in positive emotional states. Specifically, students felt successful when they were confident with their abilities and skills. This confidence was often coupled with feelings of excitement, satisfaction and happiness. Numerous statements, similar to the following, were made by students when asked to describe the feeling of success, "But to me that reflects that I know it and am confident in it and that makes me feel successful", and "It's [success] very close to efficacy, really confidence." This indicates that level of self-efficacy (judgements of one's ability to organize skills and perform a task) is an emotional context in which feelings of success were experienced.

It has been found that peer modeling influences level of self-efficacy. Specifically, self-efficacy improves if students observe a peer develop competence, especially if the peer is perceived to have the same ability as the student (Schunk & Zimmerman, 1997). Students believe if others of equal ability can succeed, they can as well. Cooperative learning groups provide an opportunity for students to observe their peers developing conceptual knowledge, application skills and the ability to communicate statistical information. This may help to explain the reason the feeling of success was said to be most often experienced in group work contexts.

Along with students' feelings of self-efficacy, other positive affects, such as satisfaction, pride, happiness, and excitement were used to describe the context in which success was experienced. Students indicated this with statements similar to the following, "I mean being confident is part of it but its mostly real happy and being real pleased with yourself and the situation your in", and "You get really pumped and excited".

Students also indicated that when they experienced these feelings, learning statistics actually became "fun", and they wanted to learn more about the subject. This is similar to findings in the area of self-efficacy. Specifically, the importance of attending to perceived competence has been stressed it serves as a good predictor of student effort, persistence, performance and future enrollment in course in that domain (Hackett & Betz, 1989; Pajares, 1996; Pajares & Miller, 1995).

Authentic and Performance Assessment

Closely tied to the finding that students participate in cooperative learning groups is the finding that students continually put themselves through informal

performance assessments to evaluate their skills. They test their ability to apply and communicate their acquired knowledge within their study group, and this is often how they assess their success in the course. Since the formal evaluation they are receiving from the professor in the course does not influence their experience of success, one would then consider conducting the course in a manner that would facilitate this continual assessing of success by the students themselves. This seems to match well with the goals of a performance or authentic assessment-based classroom (Garfield, 1994).

Authentic assessment, which is the examination of student performance on a task relevant to life outside of school, can address the question of how to promote understanding at a level that will facilitate solving problems after the course is completed. As noted by the students, the feeling of success is often felt after the course is over when data from research projects or dissertations must be collected, analyzed and interpreted. Hubbard (1997), as noted above, states that the ability to apply knowledge to novel situations after the course is completed can be strengthened if teachers decipher between deep understanding of the material and surface learning. Specifically, surface learning is promoted by using problems or exercises that are very similar. Students can often receive very good grades because they are able to choose the appropriate procedure simply due to standard types of questions. Students memorize how problems calling for a specific procedure look instead of understanding why that procedure is used. When students leave the classroom, the problems they encounter will not look like the exercises in the text books, and those students accustom to relaying on how a problem looks will not be able to transfer their knowledge to the "real-world" situations.

One popular method of authentic assessment involves students' participation in the collection and analysis of data and then the writing and reporting of the results. This allow them to apply their skills in a practical context and allows self and teacher performance assessment. These types of projects enhance motivation if the topics are chosen by the students, if they provide the opportunity to work with real data instead of flawless textbook examples, and if they illustrate the usefulness of statistics to everyday life (Holmes, 1997). While this activity can be completed individually by students, using cooperative learning groups would promote an exchange of ideas. Smith (1998) describes an introductory statistics classroom that uses this type of authentic assessment in a group context, and the activities can be easily modified for more advanced statistics courses. As noted earlier, students participating in Smith's class indicated their approval of these methods; however, this study provides evidence that the skills assessed by these methods are an essential part of students' ability to feel successful. Starking (1997) also presents assessment models for both individual and group projects in statistics courses. A more general introduction to authentic assessment in the area of statistics education is provided by Colvin and Vos (1997). Several examples are given which can be tailored to the level of statistics instruction.

While authentic assessment has the benefit of incorporating performance assessment with the real-world application of skills, performance assessment not

involving real-world data can also be beneficial to learning. The students indicated that they explained concepts to each other in their groups which forced them to reach a deeper understanding of the material. Activities such as having students make short presentations about topics covered in the class would seem to be helpful. This activity could consist of elaborating on a topic explained in class, presenting an article that uses a technique learned in class and critiquing how adequately it was used, or creating a software tool that demonstrates concepts learned in class (e.g. characteristics of distributions). These types of activities help assess conceptual knowledge and the ability to communicate this knowledge adequately, both essential to the feeling of success.

Statistical Instruction Research:

This study shows the importance of obtaining the student perspective when conducting research pertaining to instruction in statistical methods. While quantitative studies can provide statistical information pertaining to the implementation of a technique or strategy, they can not provide information pertaining to what it feels like to be a successful student in these courses. When conducting studies that evaluate success in statistics based on expert definitions or when simply reporting expectations of students in statistics courses (e.g. Aiken, West, Sechrest & Reno, 1990; Gal & Garfield, 1997; Lehman, Lempert & Nisbett, 1988; Federer, 1978; Eddy, Jones, Kass & Schervish, 1978), it seems logical to also uncover what success is for those from whom it is expected—the students. This could give valuable insight into the inconsistency between the goals of the course set by the instructor and those set by the students.

Future Studies of Success:

A purposeful sample of graduate students was selected for the current study to investigate the meaning and context of success. Future studies that would contribute to understanding the students' perspective of success in statistics should be conducted on different populations. Specifically, it would be of interest to uncover the meaning and context of success for undergraduate students participating in these courses. One would wonder if the important elements constituting success for graduate students are relevant to undergraduates. Also, the essence of success in the current study was constructed by students studying the social sciences. A comparison of this description of success to one developed by graduate students studying mathematical statistics would be valuable. It might be shown that the experience of success is conditional upon the area of study. Since this topic of inquiry in general has been neglected, studies focusing on any population of students participating in statistical methods courses will contribute to the understanding of the student perspective of success.

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Appendix A

Dear ,

I want to thank you for your interest in my research project on the experience of success in statistical methods courses. I greatly appreciate your contribution to my understanding of this phenomenon. The purpose of this letter is to reiterate the nature and purpose of the study.

Through the use of a qualitative methodology, I wish to understand the experience and meaning of success for graduate students who have completed several statistical methods courses. You will be asked to reflect upon thoughts, feelings and actions you experienced while enrolled in these courses. I wish to obtain a vivid account of these experiences which will facilitate my understanding of what success is and in what context it is experienced.

I value your contribution and thank you for your time and effort. If you have any questions that you wish to be addressed prior to our meeting, please don't hesitate to call me at the phone number below.

Thank you,
Sara Finney

477-2724

Appendix B

S: The purpose of my study is to describe the meaning of success for students in statistical methods courses and in what context students are experiencing that success. You were selected for the study because you had completed several statistical methods courses and had felt successful in at least one, though you may have felt successful in more than one. By sharing your experiences with me I will better be able to understand what success is and how success is experienced.

L: Okay.

S: What I want you to do is I want you to think about the statistical methods courses you have completed in which you considered yourself successful. I then want you to try to describe to me what it means to be successful in these courses.

L: Okay.

Well, I think...the one thing, I think I feel more successful...makes me feel more successful than anything else is understanding what we're taking about.

So, getting the concepts and being...feeling confident that I really have a good grasp of what we are looking at—the concepts and why we are doing what we are doing and that type of thing.

And so...and its interesting cause I think I'm actually finding that I feel more successful in some classes even after I've taken them then I did at the time.

Um....not...and then others I'm feeling less....ya know.....classes that I thought I was successful in, ya know, at the time, now I am feeling that it wasn't as successful mainly because I don't feel like I have as good a grasp on the material.

And then also I think I've found some classes.....I mean they're classes that are really challenging for me...and at the time I am going through them I hated them but...BUT, after they're finished I am glad I took them and went through all that I did to...to do whatever grade I got.

It's not really a grade thing, the way I feel about it.

I mean I want...I guess the thing is...I...it's interesting because I do want good grades but I think I want to understand it and I think when I'm working on the material that I feel I am working so I do understand it.

And as a result I think I should get a good grade because I understand it.

I think my grade would reflect, I mean SHOULD reflect what I am getting out of the material.

And so I think if I get a lower grade than I am irritated more with myself because what I did didn't reflect what I feel like I learned and got out of it.

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